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# Himalayan species of *Saccobolus*, a coprophilous genus of *Pezizales*

**Abstract**

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Two species and two varieties of *Saccobolus*, i. e. *S. diffusus, S. humidicola, S. versicolor* var. *kasauliensis* and *S. verrucisporus* var. *longisporus* are described as new to science and illustrated. *S. saccoboloides* and *S. thaxteri* are being reported for the first time from India. A few notes on these latter species, based on Indian material, are included.

## 1. Introduction

*Saccobolus* Boud. is a coprophilous genus of *Pezizales* of the *Discomycetes*. The genus is close to *Ascobolus* Pers. per Hook. However, in *Saccobolus* the ascospores are regularly united into a cluster and cemented together in definite patterns by the episporial pigment, while in *Ascobolus* the ascospores are irregularly placed or arranged in one or two rows. *Saccobolus* is accepted here as circumscribed by Brummelen (1967); we follow him also in dividing the genus into two sections, i. e. *Saccobolus* sect. *Saccobolus* and *Saccobolus* sect. *Eriobolus*.

## 2. Material and methods

All species of *Saccobolus* described in this paper were collected from dung in the wild and grown in an improvised moist chamber at 85-100% relative humidity at 30°C under diffused light. Microscopic observations are based mainly on fresh specimens. Isolated elements such as asci, ascospores and paraphyses were examined and measured in fresh crush mounts. Line drawings were made with a camera lucida. All collections have been deposited in PAN.

## 3. Results

***Saccobolus diffusus*** Kaushal & Virdi, **sp. nova** - Fig. 1. A-C.

Typus: *Virdi 7958* (PAN, holotype).

Apothecia ad 0.8 mm in diam., solitaria vel aggregata, sessilia, semiglobularia vel globularia, denique pulvinaria, virescenti-lutea, margine integro; hymenium asperum propter apices prominentes ascorum. Asci 112-144 × 28.5-32(-36.5) μm, 8-spori, raro 6-spori, clavati, pariete iodo caerulescenti. Ascosporarum fasciculi compacti, 45.5-55.5 × 18-20.5 μm; ascosporae secundum typum I, 20.5-24.5 × 9.0-10.5 μm, ellipsoideae. Paraphyses infra ad 2.5 μm latae et in apicibus

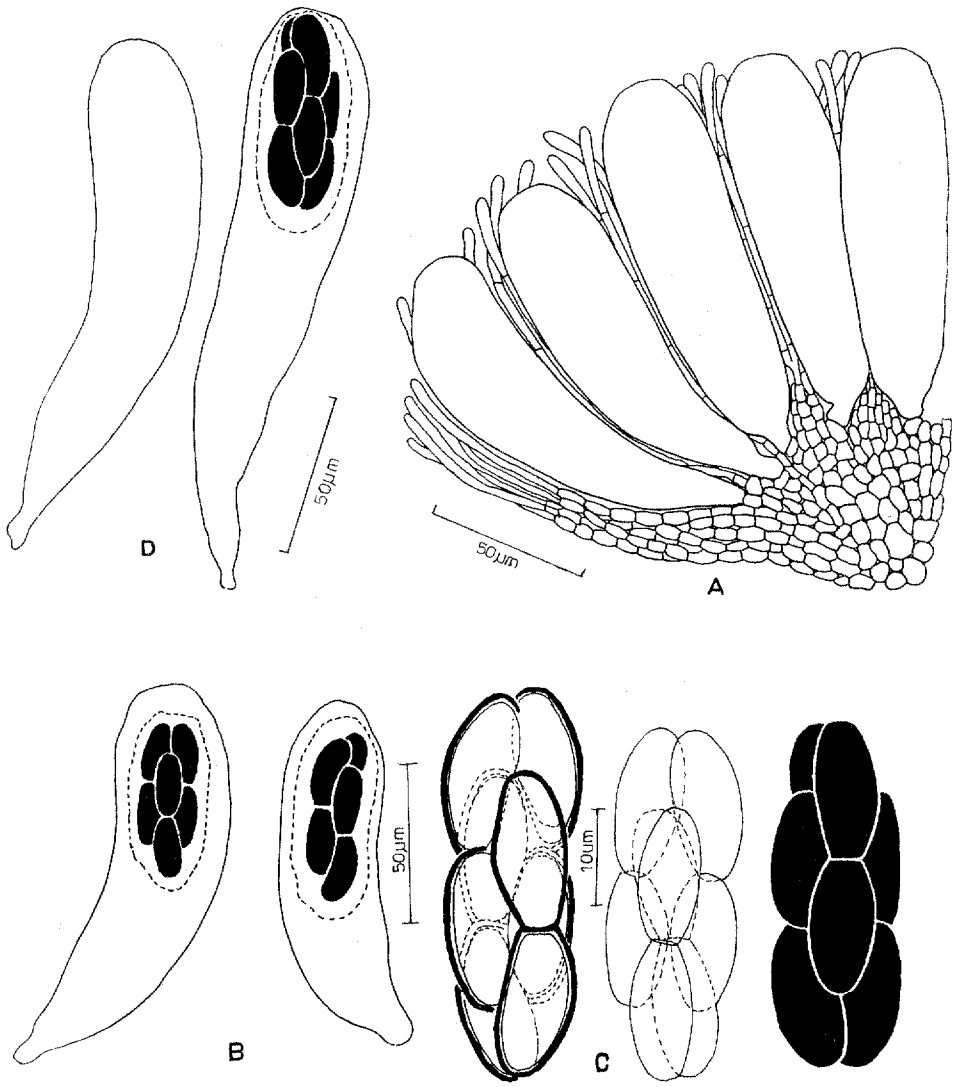


Fig. 1. *Saccobolus diffusus.* (A–C). A. Vertical section of the apothecium showing hymenium and excipulum. B. Asci. C. Ascospore arrangement. – *Saccobolus humidicola.* (D). – Asci.

4.0 μm, septatae, ramosae, ± rectae. Excipulum ad 55 μm crassum, textura globulosa-angulari, cellulis ad 12 μm diam., hypothecium indistinctum.

Apothecia up to 0.8 mm diameter, scattered to gregarious, superficial, sessile, at first subglobose to globose, obconic, finally pulvinate, greenish-yellow; external surface glabrous; margin entire; hymenium convex, dotted over and roughened with tips of mature protruding asci. Asci 112–144 × 28.5–32(–36.5) μm, 8-spored, rarely 6-spored, clavate, tapering abruptly into a short stalk like base, apices subtruncate, J+ve. Ascospore cluster 45.5–55.5 × 18–20.5 μm, 8-spored, compact, not shortened with maturity, surrounded by a gelatinous sheeth, ascospores arranged as pattern I; ascospores 20.5–24.5 × 9.0–10.5 μm, ellipsoid, at first hyaline, violaceous-brown, finally brown, smooth. Paraphyses up to 2.5 μm wide below, 4.0 μm wide above, simple or branched, septate, filled with greenish-yellow contents in the upper half. Excipulum up to 55 μm thick, composed of textura globulosa-angularis, cells up to 12 μm across, hypothecium indistinct.

Collection examined: India, on cow dung from Kasauli, Himachal Pradesh, 28. 11. 1978, *Virdi 7958* (PAN).

*S. diffusus* is a species closely related to *S. citrinus* Boud., but the latter differs from it in having smaller apothecia, smaller ascospore clusters and smaller, ornamented ascospores. Another related species, *S. glaber,* differs in having lemon-yellow apothecia, large asci (150–275 × 25–48 μm), bigger ascospore cluster (50–68 × 16–25 μm), bigger ascospores (22–29 × 8.5–14.5(–16) μm) and in having paraphyses-like hyphae in the upper part of the excipulum.

***Saccobolus humidicola*** Kaushal & Virdi, **sp. nova** - Fig. 1. D, 2. A–C.

Typus: *Virdi 7956* (PAN, holotype).

Apothecia sessilia, 1.2 mm in diam., initio globularia, cylindrica, denique patellata, virescenti-lutea, furfuracea, marginata. Asci (175.5–)185–221 × 39–46 μm, 8-spori, raro 6 vel 4-spori, late clavati, apice sub-truncati vel truncati, pariete iodo caerulescenti. Ascosporarum fasciculi compacti, 57–72 × (18–)19.5–22 μm, ascosporae secundum typum Ia, 22.5–24.5 × 9–11 μm, ellipsoideae, brunneo-violascentes, striis longitudinalibus. Paraphyses simplices vel ramosae, cylindricae, 3.0–6.0 μm crassae. Excipulum ad 115 μm crassum, textura angulari-globulosa, cellulis ad 18.0 × 12.0 μm, hypothecium indistinctum.

Apothecia up to 1.2 mm in diameter, solitary to gregarious, sessile, superficial, at first globose then cylindrical and finally discoid, greenish-yellow when young, golden-yellow at maturity; external surface paler than hymenium; anchoring hyphae 6 μm wide, golden-yellow, septate, branched, inflated up to 18 μm; margin entire; hymenium flat to convex. Asci (175.5–)185–221 × 39–46 μm, 8-spored, rarely 6 or 4-spored, broadly clavate, apices subtruncate to truncate, J+ve. Ascospore cluster 57–72 × (18–)19.5–22 μm, compact, surrounded by a thick gelatinous envelope, ascospores at first irregularly placed, finally arranged as pattern Ia, 22.5–24.5 × 9–11 μm, ellipsoid, violaceous-brown, striated, with few longitudinal and oblique striae, paraphyses 3.0–6.0 μm wide below, slightly enlarged above, simple or branched, cylindrical, septate, greenish-yellow contents present in the upper half. Excipulum up to 115 μm thick, composed of textura angularis-globulosa, cells up to 18.0–12.0 μm, at periphery cells up to 42 μm in diameter, hypothecium indistinct.

Collection examined: India, on buffalo dung from Kasauli, Himachal Pradesh, 16. 9. 1979, *Virdi 7956* (PAN).

*S. humidicola* is characterized by large golden-yellow apothecia with numerous anchoring hyphae. It is close to *S. glaber* but the later differs in having larger asci and bigger ascospores. In *S. glaber* the ascospores are completely smooth, although at maturity, the episporium may show irregular fissures.

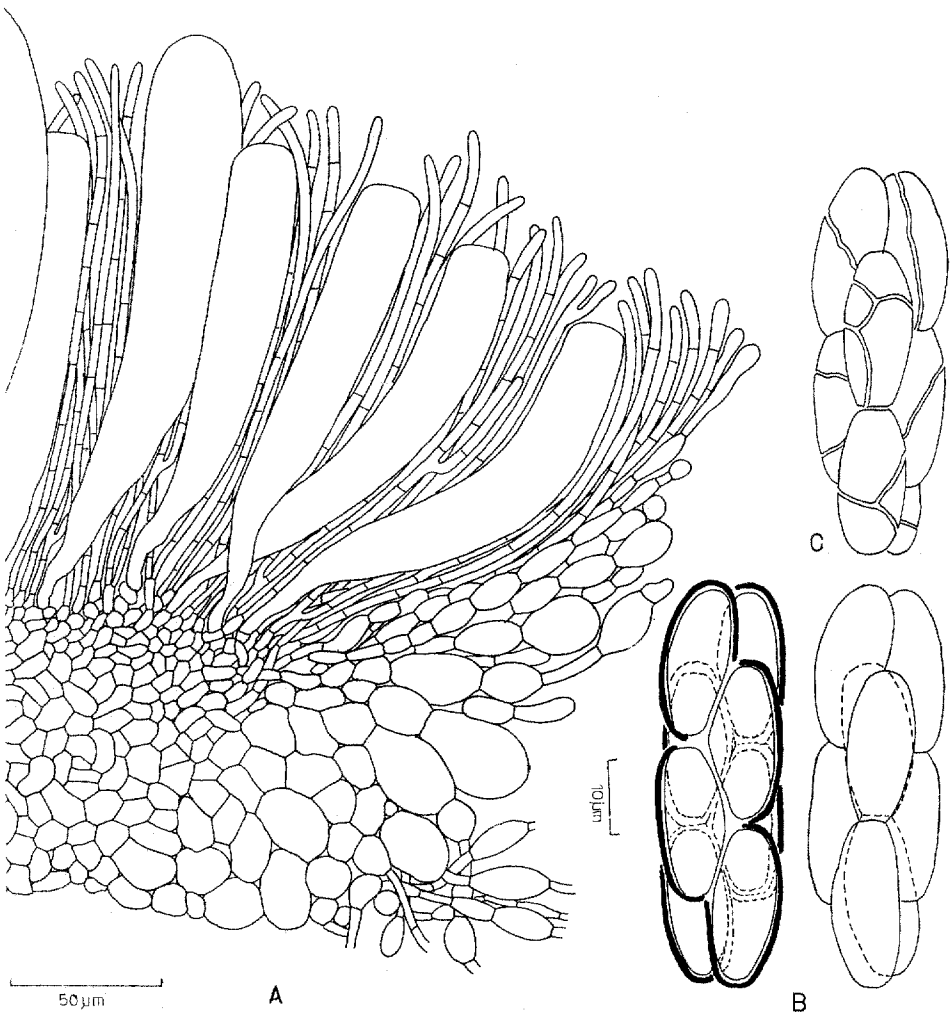


Fig. 2. *Saccobolus humidicola.* (A–C). A. Vertical section of the apothecium showing hymenium and excipulum. B. Ascospore arrangement. C. Ascospores with longitudinal and vertical crevices.

***Saccobolus versicolor*** (Karst.) Karst var. ***kasauliensis*** Kaushal & Virdi, **var. nova** – Fig. 3 A–D.

Typus: *Virdi 7960* (PAN, holotype).

Apothecia 0.2–0.4 mm in diam., solitaria vel aggregata, initio semiglobularia, denique lenticularia, albida, carnosa; hymenium pulvinaris. Asci 60.5–78(–89) × 16–19.5 µm, 8-spori, clavati, apice truncati, pariete iodo caerulescenti. Ascosporarum fasciculi compacti 33.5–37.0 × 11–14.5 µm, 8-spori; ascosporae secundum typum II, 13.0–15.7 × 6.5–8 µm,ellipsoideae. Paraphyses infra 1.5–3.0 µm et in apicibus clavatis 5.0 µm latae, filiformes, simplices vel furcatae, septatae, hyalinae. Excipulum ad 55 µm crassum, textura globulosa-angulari, cellulis ad 8 µm diam.; hypothecium textura intricata, hyphae ad 2.0 µm crassae.

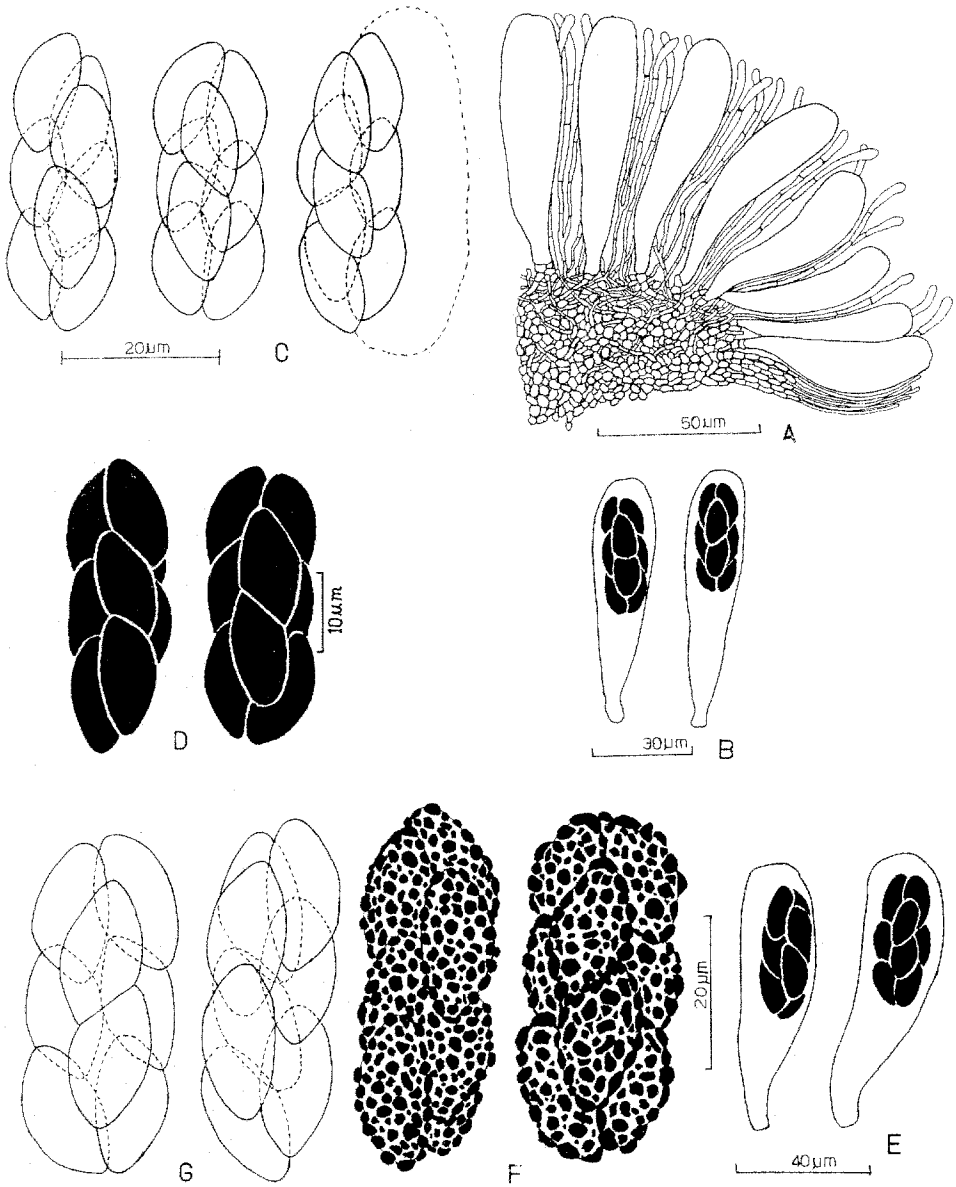


Fig. 3. *Saccobolus versicolor* var. *kasauliensis*. (A–D). A. Vertical section of the apothecium showing hymenium and excipulum. B. Asci. C, D. Ascospore arrangement. – *Saccobolus verrucisporus* var. *longisporus*. (E–G). E. Asci. F. Warted ascospores. G. Ascospore arrangement.

Apothecia 0.2–0.4 mm in diameter, solitary to gregarious, superficial, sessile, at first subglobose to hemispherical, finally lenticular, whitish, external surface smooth; margin entire; hymenium convex, concolorous. Asci 60.5–78(–89) × 16–19.5 μm, 8-spored, clavate, apices truncate, J+ve. Ascospore cluster 33.5–37.0 × 11–14.5 μm, 8-spored, surrounded by a unilateral gelatinous envelope. Ascospores finally arranged according to pattern II, 13.0–15.7 × 6.5–8 μm, ellipsoid with narrow ends, deep violet, violaceous-brown to blackish-brown, smooth. Paraphyses 1.5–3 μm wide below, up to 5 μm wide at their clavate apices, filiform, simple or branched at all levels, septate, hyaline. Excipulum up to 55 μm thick, composed of textura globulosa-angularis, cells up to 8 μm across, interspersed with septate hyphae; hypothecium composed of textura intricata, hyphae up to 2.0 μm wide.

Collection examined: India, on cow dung, Kasauli, Himachal Pradesh, 5. 1. 1979, *Virdi 7960* (PAN).

The present taxon is treated as a variety of *S. versicolor* (Karst.) Karst. (*Saccobolus* sect. *Eriobolus*). Like the typical *S. versicolor* it has lenticular apothecia and the characteristic smooth ascospores, arranged according to pattern II. The typical *S. versicolor,* however, differs in having smaller apothecia (up to 0.2 mm), larger asci (80–)100–145 × 22–37 μm), bigger ascospore clusters (40–60 × 14–19(–23) μm) and bigger ascospores (13–21.5(–23.5) × 6.5–9.5(–10.5) μm). *S. depauperatus*, a closely related species, differs from the present collection in having violet apothecia and purplish-brown, smaller ascospores (10–14.5 × 5–7.5 μm).

***Saccobolus verrucisporus*** Brumm. var. ***longisporus*** Kaushal & Virdi, **var. nova** – Fig. 3 A–C.

Typus: *Virdi 7962* (PAN, holotype).

Apothecia 0.3–0.6 mm diam., solitaria, sessilia, semiglobularia vel cylindrica, albida. Asci 80–93 × 24.5–27.5(–29.5) μm, 8-spori, clavati, apice subtruncati, pariete iodo caerulescenti. Ascosporarum fasciculi compacti, 45–51 × 18–23 μm. Ascosporae secundum typum II, 18.5–22.5 × 10.5–12.75 μm, ellipsoideae, sparse verrucis crassis instructae. Paraphyses infra 1.5–2.5 μm et in apicibus 4 μm latae, filiformes, simplices vel furcatae, septatae, hyalinae. Excipulum ad 60 μm crassum, textura globulosa-angulari, cellulis ad 9 × 5 μm diam.; hypothecium textura intricata.

Apothecia 0.3–0.6 mm in diameter, scattered, superficial, sessile, at first subglobose, finally somewhat cylindrical, white; external surface smooth; margin entire; hymenium roughened by protruding ascal tips. Asci 80–93 × 24.5–27.5(–29.5) μm, 8-spored, clavate, apices obtuse to subtruncate, J+ve. Ascospore cluster 45–51 × 18–23 μm, compact, surrounded by a unilateral sheath. Ascospores finally arranged as pattern II, 18.5–22.5 × 10.5–12.75 μm, ellipsoid, violaceous-brown to brown, ornamented with coarse warts. Paraphyses 1.5–2.5 μm wide below, up to 4 μm at apices, filiform, simple or branched at all levels, septate, hyaline. Excipulum up to 60 μm thick, composed of textura globulosa-angularis, cells up to 9 × 5 μm across, interspersed with septate hyphae having subglobose to elliptically swollen ends, hyphae up to 1.7 μm wide; hypothecium composed of textura intricata, hyphae 1.7 μm wide.

Collection examined: India, on cow dung, Kasauli, Himachal Pradesh, 14. 1. 1979, *Virdi 7962* (PAN).

Although the substrate of the Indian material of *S. verrucisporus* is not roe-deer (see Brummelen 1967), the final, somewhat cylindrical shape of the white apothecia, the ascospore arrangement (Pattern II) and the ornamentation of coarse warts are the characters typical of *S. verrucisporus.* However, the variety *longisporus* has larger apothecia, smaller asci with subtruncate apices, much bigger ascospore clusters and ascospores, the latter being ellipsoid.

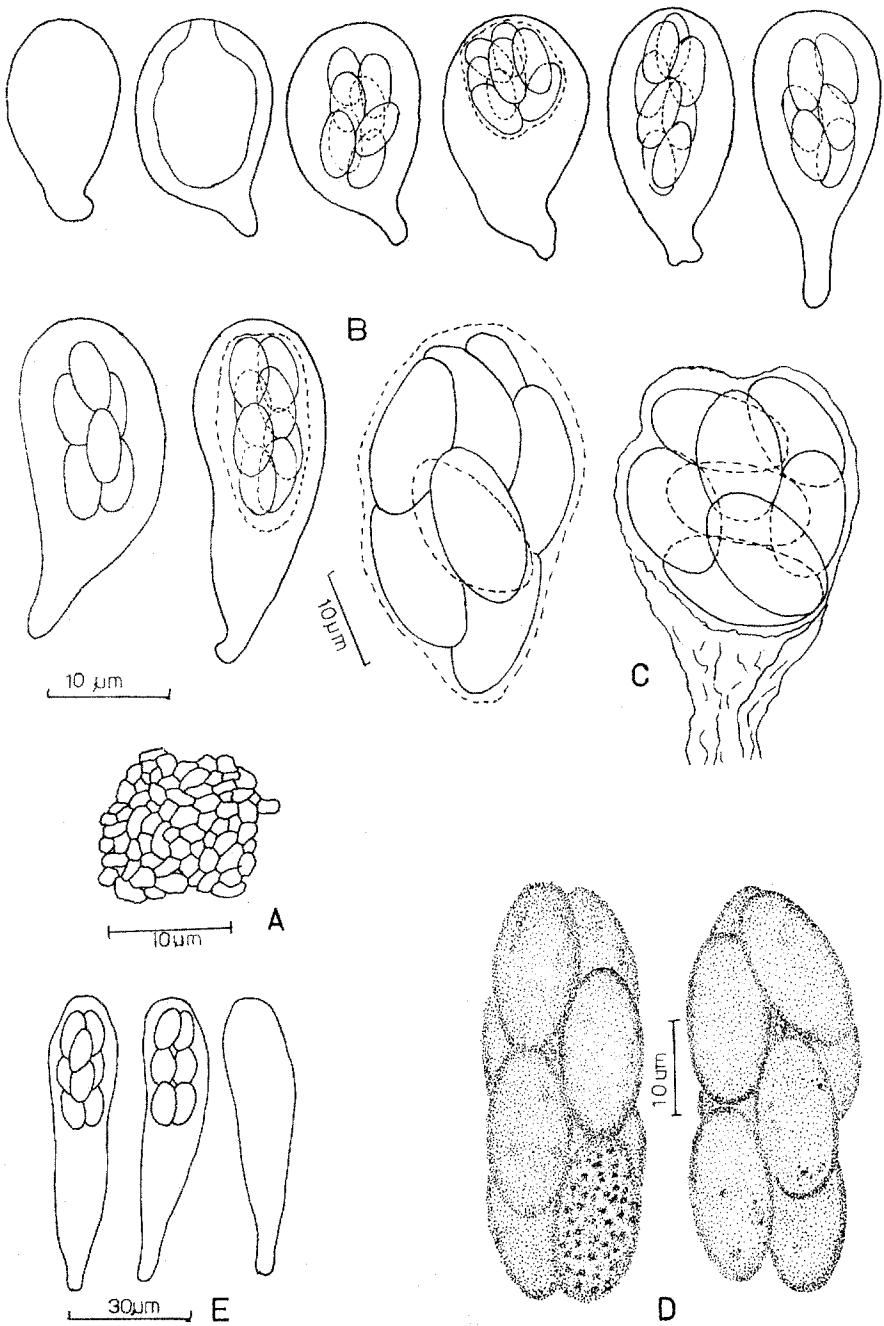


Fig. 4. *Saccobolus saccoboloides.* (A-D). A. Part of excipulum. B. Asci. C. Irregularly arranged ascospores. D. Ascospore arrangement when young. - *Saccobolus thaxteri.* (E). - Asci.

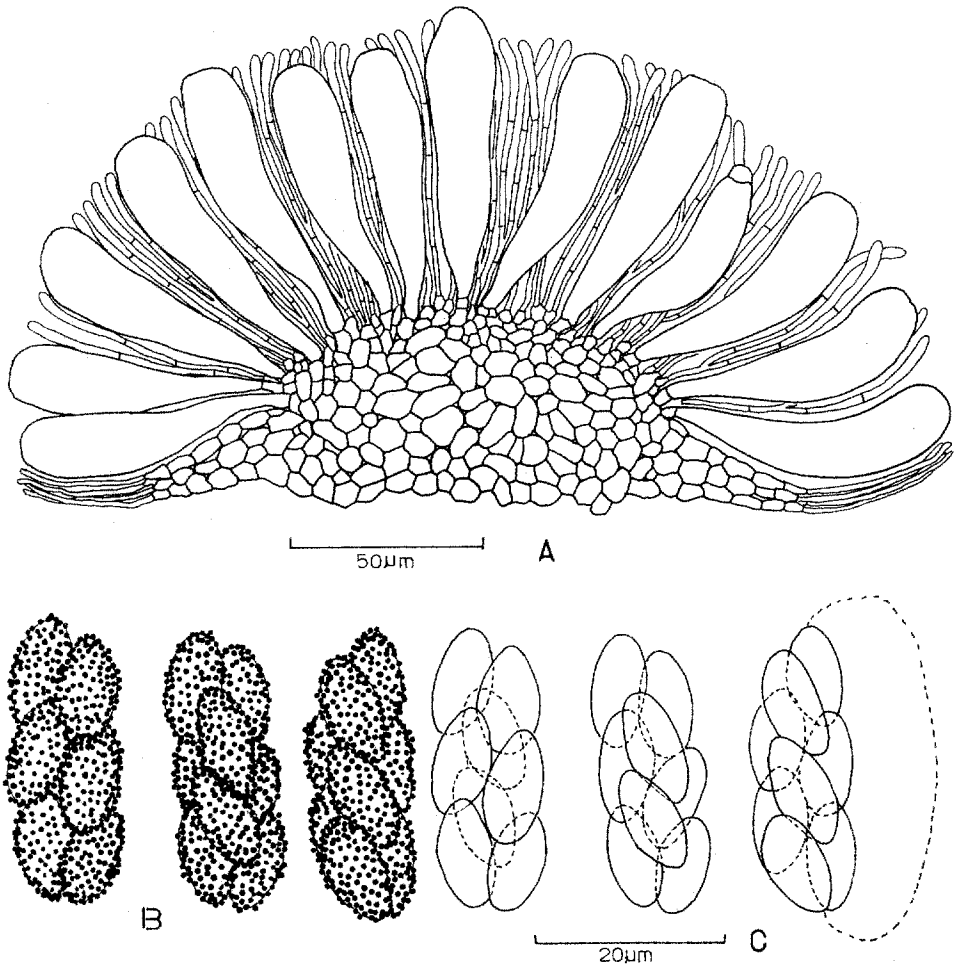


Fig. 5. *Saccobolus thaxteri.* (A–C). A. Vertical section of the apothecium showing hymenium and excipulum. B. Warted ascospores. C. Ascospore arrangement.

***Saccobolus saccoboloides*** (Seaver in Dodge & Seaver) Brumm. in Persoonia Suppl. 1: 168 (1967) – Fig. 4. A–D.

The minutely roughened ascospores, arranged at first according to pattern I, and finally becoming free from each other and irregularly placed, are characteristics of *S. saccoboloides.* However, the Kasauli collection has slightly smaller apothecia (up to 0.4 mm in diameter) and smaller asci (57.5–112 × 25.0–43.0 µm) than reported by Brummelen (1967). The other marked features of the species are subglobose to lenticular, rusty brown apothecia; 8-spored, clavate to subglobose, J+ve asci; 18.5–21 × 10.5–11.5 µm, violaceous-brown to brown, smooth to minutely roughened ascospores; 2–4 µm wide, filiform, simple or branched paraphyses; excipulum composed of textura angularis, cells up to 10 × 6 µm in diam. and an indistinct hypothecium.

Collection examined: India, on buffalo dung, 12. 9. 1979, *Virdi 7955* (PAN).

***Saccobolus thaxteri*** Brumm. in Persoonia Suppl. 1: 197 (1967) - Fig. 4 E, 5 A–C.

Brummelen (1967) reported this species from dung of goat; the type is cultivated material from a moist chamber and was grown on filter paper scattered with squirrel dung. Our findings extend the range of this species to elephant dung. The Indian collection is in full agreement with the description of the species. Its marked features are: apothecia up to 0.4 mm in diameter, obconical to pulvinate, white to pale violet; asci 64–76 × 17.5–19 µm, 8-spored, apices clavate to subtruncate, J+ve; ascospores arranged in a cluster according to pattern II, measuring 31.3–35.2 × 11.2–13.0 µm; ascospores 10–12.5 × 6–7.5 µm, ellipsoid, purplish-brown with scattered isolated warts; the excipulum (flesh sensu Brummelen, 1967) is also rather thin (not exceeding 52 µm) and is formed of colourless textura globulosa-angularis (as reported by Brummelen, 1967).

Collection examined: India, on elephant dung from Chatbir Park, Patiala, Punjab, 2. 4. 1979, *Virdi 7961* (PAN).

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**Reference**

Brummelen, J. V. 1967: A world-monograph of the genera *Ascobolus* and *Saccobolus (Ascomycetes, Pezizales)*. - Persoonia Suppl. **1.**

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